UNITED STATES AIR FORCE RESEARCH LABORATORY

PASSIVE AIRCRAFT STATUS SYSTEM (PASS)
Design and Analysis

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Human Effectiveness Directorate
Deployment and Sustainment Division
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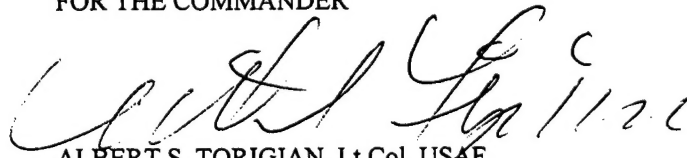
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This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

ALBERT S. TORIGIAN, Lt Col, USAF
Deputy Chief
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13. ABSTRACT *(Maximum 200 words)*

The Passive Aircraft Status System (PASS) concept addresses the timing and accuracy of aircraft information (system failures, consumables, status, etc.) available to maintenance personnel and to alleviate maintenance issues by providing accurate and detailed information to maintenance environment before the aircraft landing. This is the second phase of a three-phase effort. The design and analysis study consisted of collecting relevant data at operational bases, analyzing the data results, developing and prioritizing the approaches, and recommending concepts for the laboratory demonstration.

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1 PURPOSE

The purpose of the design and analysis phase was to define the functions required to fulfill the Passive Aircraft Status System (PASS) concept, identify potential different approaches for a PASS implementation, and prioritize the recommended approaches to develop the concept for a field demonstration.

2 INTRODUCTION

The PASS concept addresses the timing and accuracy of aircraft information (system failures, consumables, status, etc.) available to maintenance personnel and to alleviate maintenance issues by providing accurate and detailed information to the maintenance environment before the aircraft landing. The maintenance community uses this information to plan and schedule the aircraft's next activity (fly or fix).

This phase of the PASS concept study consisted of collecting relevant data at operational bases, analyzing the data results, developing and prioritizing the approaches, and recommending concepts for the laboratory demonstration.

3 PASS CONCEPT

The fundamental and most critical maintenance requirement that the PASS concept fulfills is notifying key flightline maintenance supervisors of aircraft status and any detailed failure information before landing. This in-depth condition of the aircraft can be used to start the maintenance and debrief cycles simultaneously. The following paragraphs describe today's operational method and provide a concept of future "to-be" methods with PASS as a performance enhancement for improving legacy systems and new weapon systems platforms in the out years.

3.1 Today (AS-IS)

In today's environment, pilots typically radio a code squawk when returning from a mission. This code squawk is a high-level status report providing the general condition of the aircraft, as assessed by the pilot during the mission. To meet the requirements of the remaining flying schedule or other flightline maintenance activities, a maintenance supervisor uses this code squawk, along with other information, to determine the type of maintenance to be performed on the aircraft. Other information used in determining the maintenance needed to turn the aircraft for its next sortie includes evaluating the anticipated required turn time against available flightline resources (people, equipment, tools), aircraft, or system faults. In today's environment, a code squawk is generally inconsistent with the final aircraft status condition after debrief is completed. The timing of this squawk is inconsistent and may occur anywhere from entry into the landing pattern to just before engine shutdown. These aircraft squawks are the aircrew's determination of the aircraft condition. These squawks are in the form of status codes.

Status codes are used to notify the maintenance community if the aircraft is capable

1

of being used for the next mission without maintenance (other than the normal turn requirements). The status codes used in AF operations are as shown in Table 1 – Status Codes.

Table 1 – Status Codes

Code	Status
Code 0	Ground Abort
Code 1	Aircraft Mission Capable With No Additional Discrepancies
Code 2	Aircraft Or System Has Minor Discrepancies But Is Capable Of Further Mission Assignment Within Normal Turnaround Times
Code 3	Aircraft Or System Has Major Discrepancies In Mission Essential Equipment That May Require Extensive Repair Or Replacement Prior To Further Mission Assignment
Code 4	Aircraft Or System Has Suspected Or Known Radiological, Chemical, Or Biological Contamination
Code 5	Aircraft Or System Has Suspected Or Known Battle Damage

Brief descriptions of the significant blocks of the maintenance flow shown in Figure 1 follow:

- <u>Aircrew Squawk</u> – Aircrew squawks one of the status codes in table 1. If Code is other than "1", the system having the failure is usually identified (e.g., Code 2 – Radar).

- <u>Maintenance Notified</u> – The RF squawk information is passed on to the maintenance environment normally through the Operations Squadron or the Wing Command Post. This information may have passed through two or three sources prior to being received by maintenance and is subject to translation errors.

- <u>Aircrew arrives Debrief</u> – Maintenance debrief is an in-depth evaluation of the aircraft's condition. Current aircraft collect and store aircraft status information, requiring human intervention, to transfer that data to maintenance personnel before landing or during taxi before engine shutdown. On aircraft such as the F-15 and F-16, this information is collected and transferred to debrief via the maintenance data transfer cartridge (DTC). On other aircraft, the failure information is only available in debrief by the aircrew. The task of translating this information into a usable format is the debriefer's responsibility, who may use a DTC reader or computerized debrief system such as Computerized Fault Reporting System (CFRS) or Computerized Fault Isolation (CFI). During debrief, it may be necessary to look in the Fault Reporting Technical Orders (TOs). The debriefer ensures the aircraft forms (Air Force Technical Order [AFTO] Form 781A) reflect accurately the aircraft discrepancies and that the information is updated in the maintenance data system in use Core Automated Maintenance

System (CAMS), Integrated Maintenance Information System (IMIS), Core Automated Maintenance System For Airlift (G081), etc.) to show each discrepancy. IMIS is a maintenance environment planned for the F-22. A job must be entered in the maintenance data system before any parts can be ordered or work can be performed on that discrepancy. Flight durations are also entered at this time. This aids in upkeep of accurate aircraft information for timely completion of scheduled maintenance and other activities.

- <u>Debrief Complete/Forms Complete</u> - After debrief is completed, the maintenance technicians confirm the accuracy of the original status squawk and starts or continues the maintenance process required to turn the aircraft for its next mission.

Today, the maintenance flow, as shown in Figure 1, runs sequentially from aircraft land until crew ready for the next mission. Sometimes, some of the activities could be worked concurrently. This could be risky, however, depending on the nature of the discrepancy and the accuracy of the squawk information.

3

AS-IS

```
┌─────────────────┐          ┌─────────────────┐
│  Aircraft Land  │          │ Air Crew Squawk │
└────────┬────────┘          └────────┬────────┘
         │                            │
         ▼                            ▼
┌─────────────────┐          ┌─────────────────┐
│ Aircraft Exit EOR│         │Maintenance Notified│
└────────┬────────┘          └────────┬────────┘
         │                            │
         │              ╭─────────────────────────╮
         │              │   Squawks used to make   │
         │              │  maintenance decisions   │
         │              ╰─────────────────────────╯
         │                       │
         ▼                       ▼
```

Squawks used to make maintenance decisions

Quick Turn? —Yes→ Aircraft Quick Turn/ Integrated Combat Turnaround → Aircraft Parked

No

Aircraft Parked

Debrief/Forms completed

Air Crew Departs Plane

Air Crew Arrives Debrief   Aircraft Refueled

Debrief Complete/ Forms Complete   Aircraft Dearmed

Maintenance Receives Forms   Thru-Flight

Aircraft Ready for Air Crew

Aircraft Weapons Loaded

If Required by Debrief & Allowed by Schedule

Aircraft Ready for Maintenance → Maintenance Personnel Arrive → Maintenance Complete
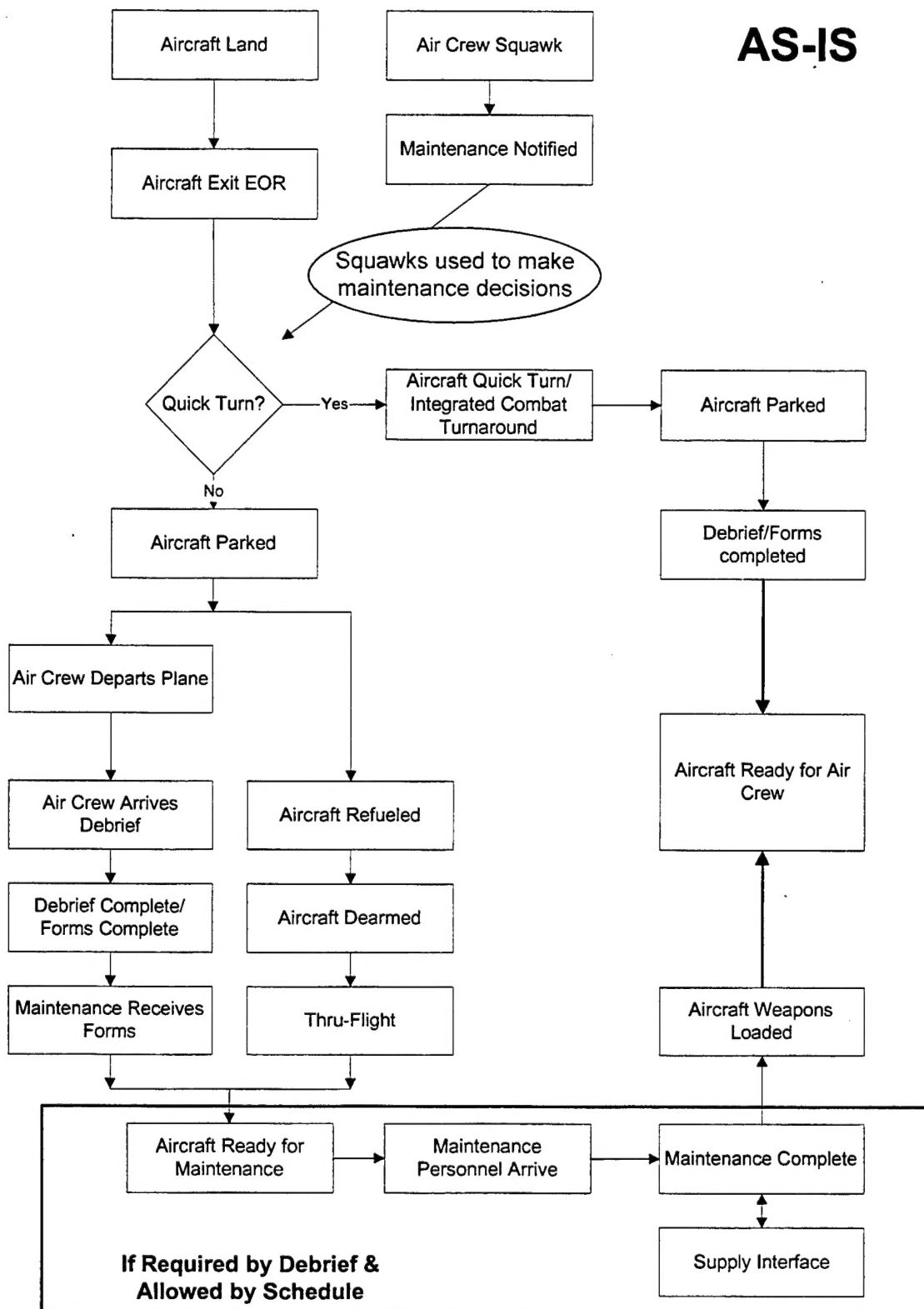
Supply Interface

Figure 1 – AS-IS Aircraft Maintenance Flow

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3.2 Tomorrow (TO-BE)

The PASS concept addresses the need for detailed information such as aircraft system and subsystem failures, fuels and munitions expenditures, etc., to be available to maintenance personnel while an aircraft is airborne, so that preparations for maintenance can be made to expedite the return of the aircraft to mission ready status. Additionally, the PASS concept attempts to alleviate maintenance issues such as determining the complete health status of the aircraft and all its major systems/subsystems needed for the next sortie. The key to the PASS concept is for this aircraft data to be collected, transferred, and translated before landing. Figure 2 – PASS Concept illustrates:

- The collection of data from the aircraft systems.

- Transferring data to the ground via Radio Frequency (RF) connection.

- The use of an interface that converts the data into a textual format (e.g., fault codes) recognizable by maintenance personnel.

The converted data are accessible via a RF or Local Area Network connection to key maintenance supervisors before the aircraft lands, allowing access to real-time status and fault data. Having this information before the aircraft lands allows maintainers to make informed maintenance decisions and more importantly, not having to make these decisions in short order. The goal of PASS is to provide accurate and detailed information to maintenance personnel in a consistent and timely manner before the aircraft landing. The PASS concept requires seamless integration with existing software tools, such as CAMS or G081, or forthcoming concepts under development, such as the System Program Office's (SPO) versions of IMIS.
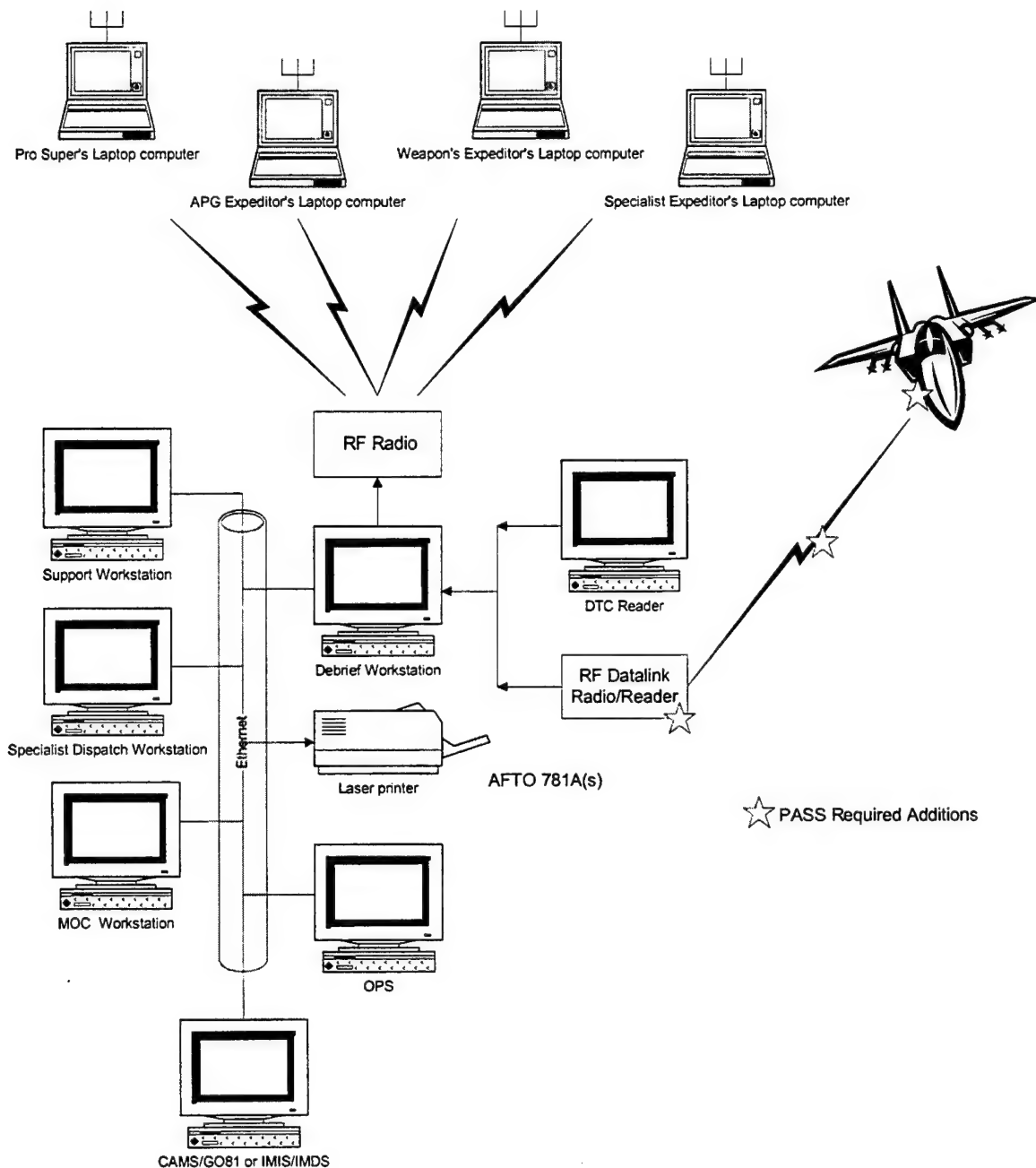
Figure 2 – PASS Concept

Labels within the figure:
- Pro Super's Laptop computer
- APG Expeditor's Laptop computer
- Weapon's Expeditor's Laptop computer
- Specialist Expeditor's Laptop computer
- RF Radio
- Support Workstation
- Specialist Dispatch Workstation
- MOC Workstation
- Ethernet
- Debrief Workstation
- Laser printer
- AFTO 781A(s)
- DTC Reader
- RF Datalink Radio/Reader
- OPS
- CAMS/GO81 or IMIS/IMDS
- ☆ PASS Required Additions

Implementation of the PASS concept puts correct and detailed data in the hands of the appropriate maintenance personnel early, which leads to better maintenance decisions in areas such as: manning, planning, part cannibalization, and determination and acquisition of necessary parts. There are underlying benefits of the PASS concept, which are quicker aircraft turn times and higher aircraft availability, which allows for a higher sortie rate. Figure 3 – TO-BE Aircraft Data Flow shows how the maintenance processes could flow using the PASS concept. This concept allows concurrent maintenance efforts with reduced risk because it is based upon current, accurate information from the aircraft.

TO-BE

```
┌──────────────┐        ┌──────────────┐
│ Aircraft Land│        │Aircraft's PASS│
│              │        │   Downlink   │
└──────┬───────┘        └──────┬───────┘
       │                       │
       ▼                       ▼
┌──────────────┐        ┌──────────────┐
│Aircraft Exit │        │ Maintenance  │
│     EOR      │        │   Notified   │
└──────┬───────┘        └──────┬───────┘
       │                       │
       │            ╭──────────────────────╮
       │            │  PASS Downlinks used to│
       │            │ make maintenance decisions│
       │            ╰──────────────────────╯
       │                    ╱
       ▼                   ▼
    ◇ Quick Turn? ◇──Yes──▶┌──────────────┐           ┌──────────────┐
       │                   │Aircraft Quick │           │Aircraft Parked│
       │                   │Turn/Integrated│──────────▶│              │
      No                   │ Combat Turn   │           └──────┬───────┘
       │                   └──────────────┘                  │
       ▼                                                      ▼
┌──────────────┐                                    ┌──────────────┐
│Aircraft Parked│                                   │ Debrief/Forms │
└──────┬───────┘                                    │  completed    │
       │                                            └──────┬───────┘
```

Air Crew Departs Plane

Aircraft Refueled

Air Crew Arrives Debrief

Aircraft Dearmed

Debrief Complete/ Forms Complete

Thru-Flight

Maintenance Receives Forms

Aircraft Ready for Maintenance

Supply Interface

Maintenance Personnel Arrive

If Required by PASS downlinked information & Allowed by Schedule

Maintenance Complete

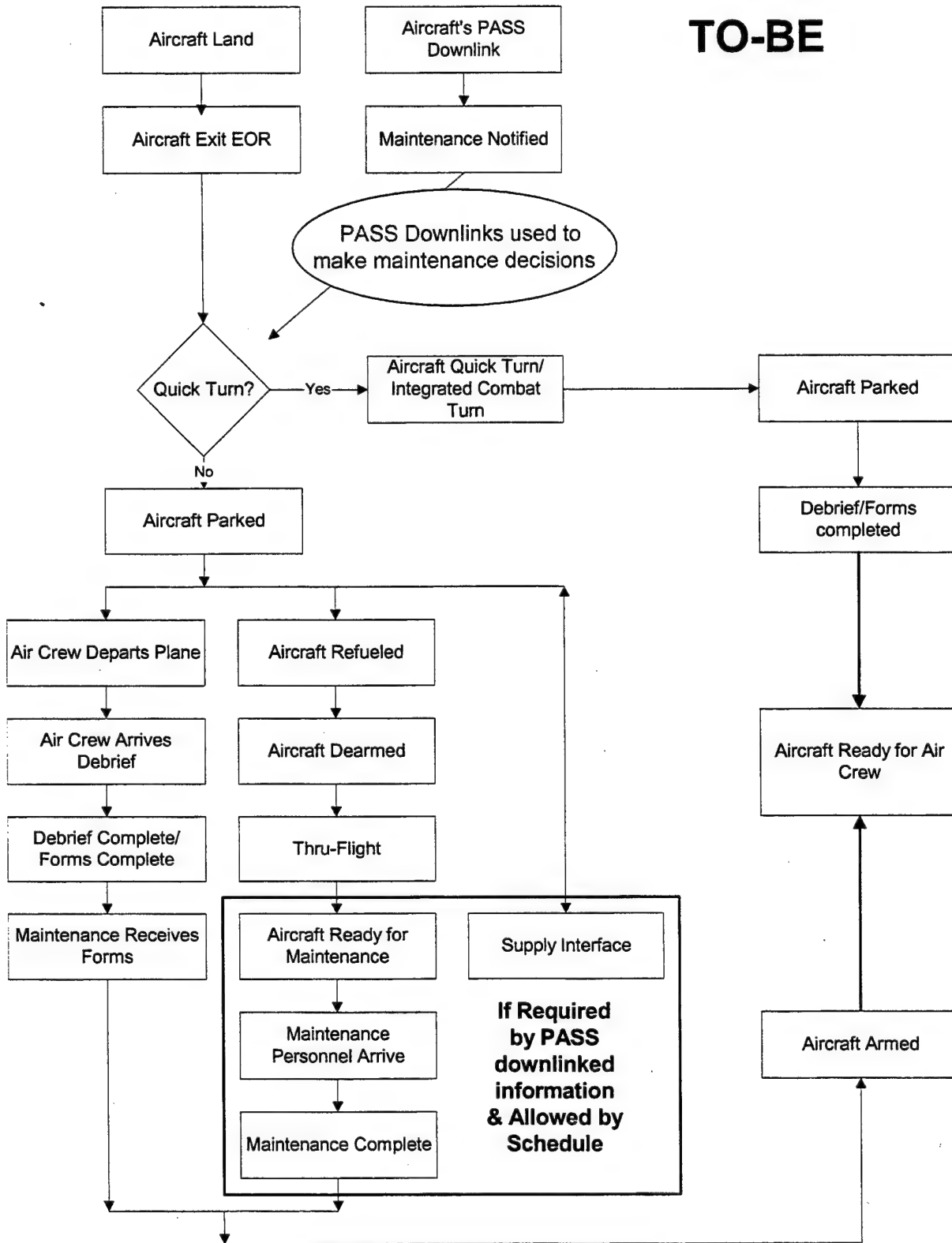Aircraft Ready for Air Crew

Aircraft Armed

Figure 3 – TO-BE Aircraft Data Flow

Brief descriptions of the significant blocks of the flow include:

- Aircraft Squawk – Relay of aircraft data is no longer dependent on the aircrew. In a passive role to the aircrew, a PASS aircraft squawks with detailed information at a designated time before landing. *Benefit: Timing is consistent and information is as accurate as the data collected; decreases data interpretation errors with human intervention.*

- Maintenance Notified – Maintenance receives the squawk via RF. It does not have to be re-transmitted by OPS personnel. *Benefit: Everybody receives information simultaneously; the aircraft data relays are less ambiguous.*

- Aircraft Exit End of Runway (EOR)– PASS data are sent again to verify original data and any other problems that occurred after original aircraft squawk. *Benefits: Data verified and any differences in squawks between flight and landing reported.*

- Aircraft Parked – *Benefits: With PASS information available, the right systems specialist may meet the plane to diagnose problems while crew is still in the aircraft. In addition, certain failures require a specific parking spot to perform maintenance; this may prevent tow of an aircraft to another location.*

- Aircrew arrives Debrief – Maintainers have detailed status data available to them. *Benefit: Proper specialist can meet the aircrew at debrief to ask detailed questions to aid in diagnosing the problem. Debrief does not require the use of a DTC. The A/C collected fault information is available via the PASS downlink.*

  o Debrief still ensures the aircraft forms (AFTO Form 781s) document the aircraft discrepancies. The Debrief personnel input the PASS information into the maintenance data system in use (CAMS, IMIS, G081, etc.) to show each discrepancy.

  o A job must be entered in the maintenance data system before any parts or work can be performed on that discrepancy. Flight durations are also entered at this time, which aid in the determination of scheduled maintenance.

- Debrief Complete/Forms Complete - After debrief is completed, the maintenance supervisors confirm previous decisions based on the PASS information. *Benefit: In the TO-BE flow, maintenance has more accurate data early and the flow runs concurrently based on the squawk, minimizing risk with the accuracy of the PASS and squawk information.*

4   USER REQUIREMENTS

Paramount to the success of the user requirements phase was getting the maintenance users involved. Interviews were conducted with Production Superintendents, Expeditors (Airplane, General [APG], Weapons, and Specialists),

Debrief, and Maintenance Operations Center Controllers at various locations, such as Mountain Home Air Force Base (AFB), ID, Shaw AFB, SC, and Charleston AFB, SC. Each user interviewed revealed different requirements and different information needs based on the tasks for which they are responsible. Table 2 – Requirements and Discussion provides only the PASS requirements obtained during the interviews. Numerous other requirements were collected from the users, which are not shown because they are beyond the scope of the PASS project and are part of the IMIS concept. Some examples of these include IMIS requirements such as electronic flying schedules, Mission Essential Systems Lists (MESLs), interface to supply, generation and display of estimated time to repair (ETTR) and estimated time in commission (ETIC), etc. IMIS is planned for the F-22.

Table 2 – Requirements and Discussion

REQUIREMENTS	DISCUSSION
AIRCRAFT – the needed information shall be captured at the time of occurrence by the aircraft and/or aircrew.	The collection of PASS information required by maintenance shall be accomplished onboard the aircraft. Most legacy aircraft were designed to collect and display avionics failure information, warnings/cautions on critical mechanical systems such as engines and hydraulics, and status of expendables such as fuel, Liquid Oxygen (LOX), and munitions. This data are a minimum requirement from the users. Other data undetected by the aircraft but experienced by the aircrew was also requested. Information such as video or audio problems, differences in indications between systems or displays, problems experienced by the aircrew's senses (sound, sight, smell, feel) and those failures in systems not collectable via aircraft data busses.
AIRCRAFT - PASS information shall provide the maximum amount of maintenance data allowable by a platform implementation.	To aid in diagnostics of complicated systems, PASS shall provide the maximum amount of maintenance data to the maintainers. This includes parameters not necessary collected with the failure indication. The desired amount of data is a "snapshot" of the aircraft taken and made available to assist in diagnostics. This "snapshot" may include airspeed, altitude, attitude and maneuvers, switch settings, mode of operation, configuration/load at time of failure, number and times of occurrences, environmental conditions, and any other information that may be captured.
DOWNLINK – the collected information shall be made available to maintenance before landing and reconfirmed prior to engine shutdown.	To fulfill the PASS concept, the collected information shall be made available to the maintenance environment at established times prior to landing. The Air Combat Command (ACC) environment determined that the information is useful if provided 15 minutes before landing and confirmed after landing, but before engine shutdown. The Air Mobility Command (AMC)

	environment determined that the information be made available at time of occurrence, again at 30 minutes before landing, and confirmed after landing, but before engine shutdown.
	AMC flights have a requirement to notify the Tanker Airlift Control Center (TACC) three hours before landing. PASS shall handle this notification without the Aircrew intervention, thereby reducing Aircrew workload.
DOWNLINK – the downlinked information shall be protected from compromise.	Due to the sensitivity of this type of information, PASS data shall be protected from compromise by encryption before transmitting. The F-22 and others are working the encryption problems and PASS can take advantage of their solutions.
DOWNLINK – the downlink shall be capable of both passive and on-demand transfer of information.	The passive mode shall be the normal mode of operation and shall not require any aircrew activation. Its timing shall be based upon planned mission profiles and shall provide transfer of information without human intervention. The on-demand mode shall be used for notifying maintenance of problems that occur during launch, engine runs, and other ground operations. It also gives the aircrew the capability to respond to ad hoc requests.
GROUND PROCESSING - The information shall be received, decoded, converted to usable format, and routed to appropriate users.	Numerous solutions are available for this area. Because of the nature of ACC's mission, most missions are launched and recovered at the same location and the aircraft turned for its next mission. This type of operation shall require the PASS information processing to be accomplished in close proximity and information quickly dispersed to the users. The concept shown in Figure 2 – PASS Concept shows the ground processing being accomplished in debrief and the information dispersed via RF to each user's Portable Maintenance Aid (PMA) or computer.
	This equipment may also reside in the Maintenance Operations Center (MOC), the Wing Command Post, or any other location that has access to the maintenance infrastructure for transfer.
	The AMC concept is different due to the many widely dispersed locations that have a need for the information. The home station, all en-route stations, the destination station, and TACC have a need for the information. This lends itself to use of a SatCom link to one location as shown in Figure 4 – Downlink to TACC or all locations as shown in Figure 5 – Downlink to All Locations (figures shown at end of this table). If the aircraft uses SatCom to transfer the information to TACC for distribution, TACC may use e-mail or a web technology could be developed to notify all locations. Each location

	may use the local maintenance infrastructure to transfer the information to the users.
DISPLAYS – the information must be filtered for each user.	Each user in the maintenance environment has different information needs therefore the information and the PASS displays must be tailored for each user.
DISPLAYS (Production Superintendent [Pro Super or P1]) PASS Pro Super displays shall provide a suggested Aircraft Status Code based on the MESL. This suggested code is then taken under consideration by the Pro Super in making the final aircraft status determination.	The suggested aircraft status code shall be determined by the most severe fault reported. Production Superintendents are interested in the overall status of the aircraft as it returns from its mission. The Pro Super makes decisions to: • Turn the aircraft via Integrated Combat Turns (ICT) or normal turns. • Refuel via hot pit or fuel trucks. • Determine parking locations for maintenance or turns. • Use the aircraft for another mission or to work malfunctions. Additionally, there are many other decisions based on the mission need and aircraft condition. These decisions are based on the aircraft status codes.
DISPLAYS (Production Superintendent [Pro Super or P1]) PASS Pro Super displays shall indicate if discrepancies are repeats or recurring write-ups.	Repeat or recurring problems require special attention by the maintenance community. The Pro Super uses this information to make decisions on the maintenance approach for these types of write-ups.
DISPLAYS (Production Superintendent [Pro Super or P1]) PASS Pro Super displays shall allow the recommended Aircraft Status Code to be changed.	Based on other real time logistics information, the status code recommended by PASS may not be an accurate reflection of the real or desired aircraft status. The Pro Super has the responsibility to ensure the code reflects the proper status.
DISPLAYS (APG Expeditor) The APG Expeditor's Aircraft Status code shall be updated real-time and synchronized with the Pro Super's codes.	If the Pro Super overrides the recommended status codes, all user screens must be updated to accurately reflect the status.
DISPLAYS (APG Expeditor) PASS shall display aircraft status and any fault information.	The APG Expeditor requires all information pertaining to the aircraft. He is responsible for managing all scheduled and unscheduled maintenance required by the aircraft. This includes: • Fuel and other expenditures. • Spectrometric oil analysis program (SOAP) samples. • Any unscheduled maintenance. • Reconfiguration, if required.

	- Inspections. - Time Compliance Technical Orders (TCTOs). - Time Change Items (TCIs). - Other scheduled maintenance.
DISPLAYS (APG Expeditor) PASS shall indicate if faults are repeat or recurring write-ups.	Repeat or recurring problems require special attention by the maintenance community and the APG Expeditor must track its progress.
DISPLAYS (APG Expeditor) APG Expeditor requires the Work Unit Code (WUC) for each discrepancy.	The discrepancy information needed is the name of the aircraft system, its WUC, a description of the problem and if it is a repeat or recurring problem. The Expeditor will use this information to track and manage maintenance being performed.
DISPLAYS (APG Expeditor) * PASS shall display remaining fuel load.	AMC aircraft are refueled as needed for the next leg of their mission. They do not always require a full fuel load for each launch as ACC aircraft require. The remaining fuel load shall help them determine if refueling is necessary.
DISPLAYS (Specialists Expeditor) PASS shall display all discrepancy information.	The Specialist Expeditor controls and dispatches the specialists to fulfill the APG Expeditor's request for accomplishment of required maintenance. The Specialist Expeditor needs all information available including: - The fault codes. - Fault descriptions. - Any "snap shot" information available.
DISPLAYS (Specialists Expeditor) PASS shall indicate if faults are repeat or recurring write-ups.	Repeat or recurring problems require special attention by the maintenance community and the Specialist Expeditor must control the maintenance on these types of problems.
DISPLAYS (Weapons Expeditor) PASS shall display all weapon system discrepancy information.	The Weapons Expeditor is responsible for any scheduled and unscheduled maintenance required on the weapons, as well as arming and de-arming the aircraft as required. He also reconfigures and uploads, as required, for the next mission.
DISPLAYS (Weapons Expeditor) PASS shall display weapons expenditures or weapons remaining inventory.	The Weapons Expeditor is responsible for any scheduled and unscheduled maintenance required on the weapons, as well as arming and de-arming the aircraft as required. He also reconfigures and uploads, as required, for the next mission.
DISPLAYS (Debrief) PASS shall display all discrepancy information and aircraft status.	Debrief is responsible for ensuring the discrepancies are annotated in the aircraft forms (AFTO Form 781's) and loaded into the Maintenance and Diagnostics Information System (MDIS).

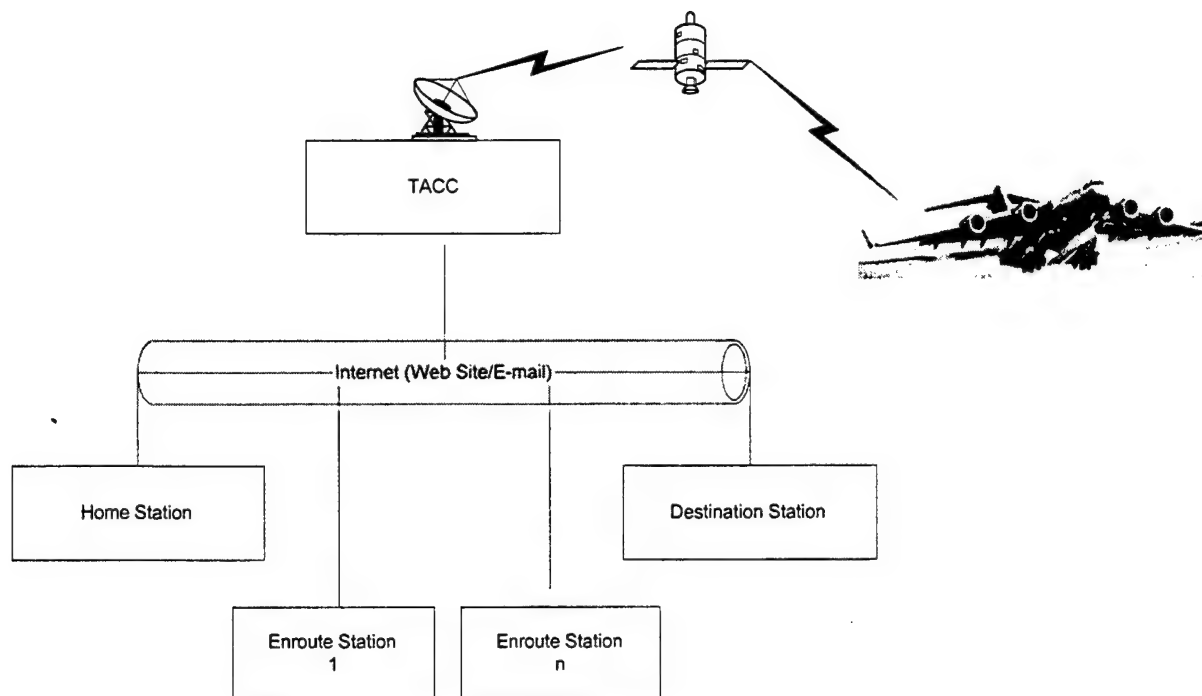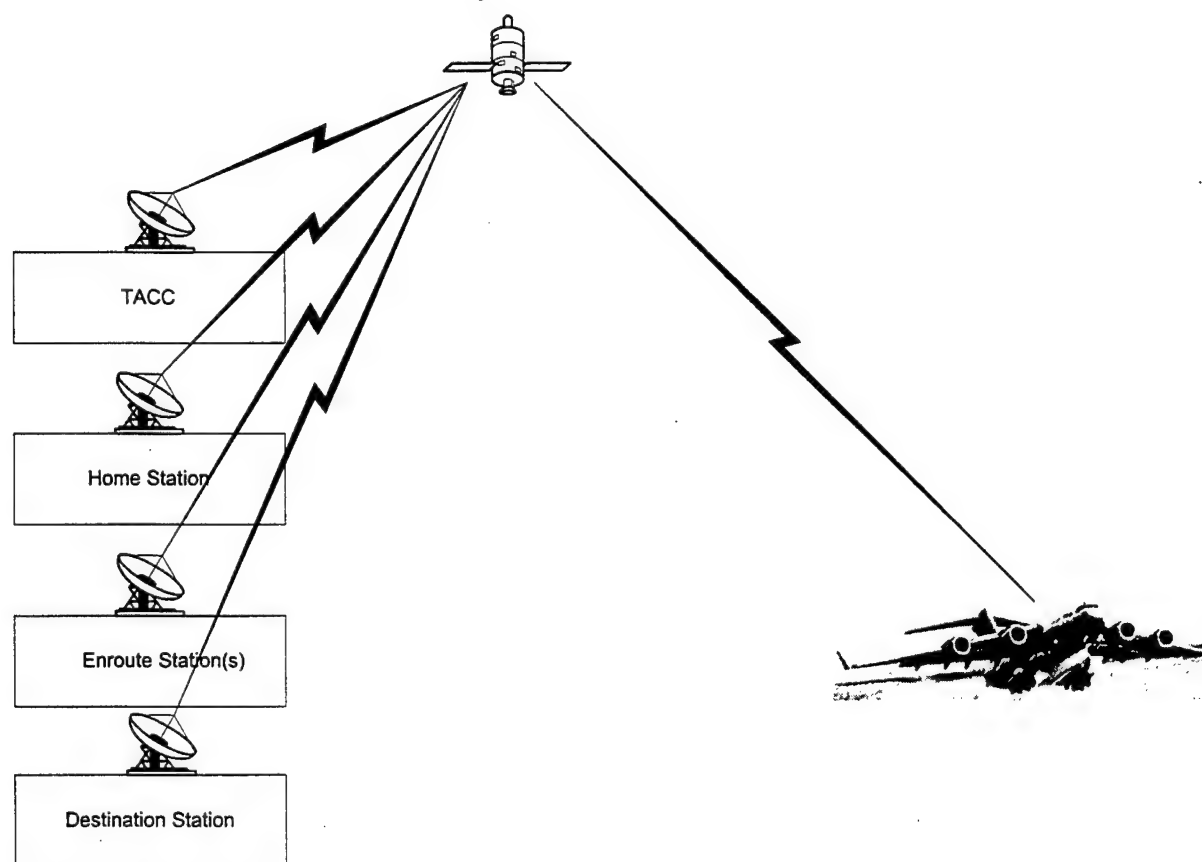|	
DISPLAYS (Debrief) PASS shall interface with existing or future Maintenance & Diagnostic Information System (MDIS) to enter the discrepancies.	Current and future MDISs are weapon system specific. The two current MDISs are GO81 (AMC specific) and CAMS (ACC specific). Some weapon systems have computerized debrief systems that interfaces with the MDIS. For example, CFRS or Fault Reporting/Fault Isolation is used for the F-15, IMIS is planned for use with the F-22, and other weapon systems have plans to consider or are considering a computerize debrief capability in the future. The PASS concept shows the downlinked information interfacing with the maintenance data information system thereby decreasing the workload and streamlining the debrief process.
DISPLAYS (Maintenance Operations Center [MOC] / Military Aircraft Coordination Center [MACC]) PASS shall display the suggested Aircraft Status Code and the aircraft failure information used to set the recommended status codes.	MOC/MACC is a monitoring agency at the Wing level.
DISPLAYS (MOC/ MACC) MOC/MACC Aircraft Status code shall be updated real-time and synchronized with Pro Super.	MOC/MACC is a monitoring agency at the Wing level. The aircraft status it reports upward must reflect the Pro Super's choice of aircraft status and system WUC's.
DISPLAYS (MOC/MACC) PASS shall display the WUC for each discrepancy.	MOC/MACC is a monitoring agency at the Wing level. The aircraft status it reports upward must reflect the Pro Super's choice of aircraft status and system WUC's.
DISPLAYS (TACC) * PASS shall inform TACC of failures at time of occurrence.	TACC monitors all AMC assets while airborne. Today they are notified of takeoffs and landings by MACC and aircraft status three hours out by the aircrew. PASS will accomplish these notifications and will keep TACC updated as failures occur.
DISPLAYS (TACC) * PASS shall inform TACC of the aircraft's status three hours before landing.	TACC monitors all AMC assets while airborne. Today they are notified of takeoffs and landings by MACC and aircraft status three hours out by the aircrew. PASS will accomplish these notifications.
DISPLAYS (TACC) * PASS shall provide the Alpha Status of the aircraft.	TACC requires the Alpha status of the aircraft. This status is used to identify the A/C's capability as it pertains to its next mission. For example, some routes require multiple FMC INS navigation systems while other routes to the same destination only require only one functional INS navigation system. An Alpha 1 A/C has no restrictions while the other Alpha statuses denote restrictions based on system malfunctions and planned routing to next station.
* = Requirements for AMC only.	

Figure 4 – Downlink to TACC

Figure 5 – Downlink to All Locations

5 DESIGN(S)

Several weapon systems were analyzed during the data collection. Detailed information for each specific weapon system is out of scope for this effort. The following is a generic view of the design considerations for implementation of the PASS system.

5.1 Aircraft

In general, for existing weapon systems, the central computer requires an interface with the downlink. The central computer software must be analyzed for the following:

- Expandability – Can the central computer hold the additional PASS processing?

- Upgradeability – How must the central computer be modified to include PASS requirements? (Embedded software, flash memory, etc.) Are the tools to modify the system accessible and cost effective?

- Interface with data link – Does the central computer interface with the Data Link or is more hardware required.

- Scalability – What PASS requirements are feasible? Based on the platform what data are available to PASS?

- Encryption – Encryption processing of PASS data

Once deemed feasible, the central computer's detailed software requirements for PASS must be defined and implemented by a team of software developers familiar with the existing central computer software upgrade procedures. Upgrades must be made following the standard upgrade software process for the platform. Testing and/or certification must also be considered.

For future weapon systems, the obvious design is to embed PASS requirements in the original requirements and design of the aircraft architecture.

5.2 Downlink

While most military aircraft do not currently have a downlink capability, future Federal Aviation Authority (FAA)-required upgrades include the Global Air Traffic Management (GATM) system. GATM has a downlink capability that has potential for use as a PASS downlink. Current military avionics planning documents shows GATM upgrades for C-17, C-141, C-5, C-130, etc. within the next five years.

5.3 Ground Processing

In general, for existing weapon systems, debrief processing requires an RF interface with the downlink. The debrief computer software must be analyzed for the following:

- Expandability – Can the debrief computer hold the additional PASS processing?

- Upgradeability – How must the debrief computer be modified to include PASS requirements? (Embedded software, flash memory, etc.) Are the tools to modify the system accessible and cost effective?

- Interface with data link – How does the debrief computer interface with the Data Link or is more hardware required?

- Scalability – What PASS requirements are feasible? Based on the platform what data are available to PASS?

- Decryption – How will the data be decrypted?

- Integration – How difficult to interface with data management systems? How would we update and access existing databases to populate with or query for PASS information?

Once deemed feasible, the debrief computer's detailed software requirements for PASS must be defined and implemented by a team of software developers familiar with the existing debrief computer software upgrade procedures. Upgrades must be made following the standard upgrade software process for the platform. Testing and/or certification must be performed.

For future platforms, the obvious design is to embed PASS requirements in the original requirements and design of the aircraft architecture.

5.4 Displays

Displays must be based on a language compatible with the existing debrief system or data management system. The design for the PASS demonstration shall be based on the display requirements as defined in section 4. The concept is to take the current paper status sheet used by the maintenance community today and transform it into an electronic status sheet with access to PASS data. Applying Human Factors principals, the PASS data can be presented in a consistent manner across the user screens, using good human-computer interface (HCI) standards, while filtering data as defined by the logged-in user.

6   RECOMMENDED APPROACH FOR PASS DEMONSTRATION

The recommended approach for the PASS field demonstration system requires two computers: one to simulate the aircraft operation, and one for the ground operation. The two PMAs, as shown in Figure 6 – Computer Communication Diagram, will be connected via RF modem to simulate the downlink capability.
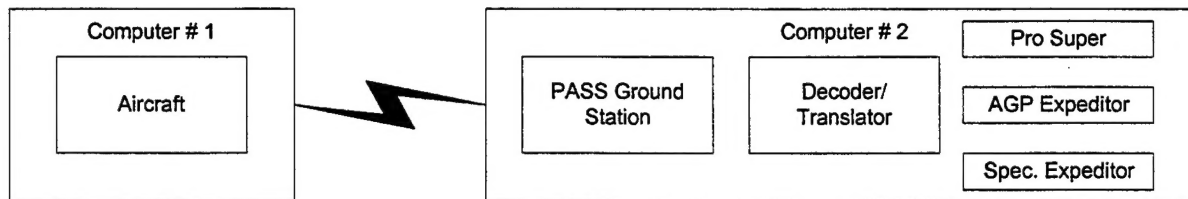
Figure 6 – Computer Communication Diagram

Computer #1 will have canned scenarios depicting a number of aircraft identified by different tail numbers returning from a sortie. Each tail number will have a corresponding data set depicting different failures, expenditures, and aircraft status. Timing of the transfer of information will be scalable to allow a demonstration of the concept without having to wait 15 minutes between airborne squawk and ground confirmation.

Computer #2 will receive and decode the RF signal from computer #1. Computer #2 will convert the information to a usable format by using look-up tables, similar to those in the Fault Reporting TO, which identify the system at fault along with a fault description for each fault. Comparing the system at fault against the Minimum Essential System List will provide the recommended status and comparing it against a table similar to the aircraft –06 Work Unit Code Manual will provide the WUC. Additionally, computer #2 will display the information and is the computer used to establish privileges, based on the requirements for the individual signing in. Only one display will be available without re-accomplishing the sign-in procedures.

7 RECOMMENDED APPROACH FOR PASS IMPLEMENTATION

Each existing weapon system will require an in-depth look at its equipment configurations and planned upgrades for the airframe and the maintenance infrastructure. It is recommend that the implementation of PASS be planned as part of the GATM modifications. GATM will require software/hardware changes, some of which are very similar to those needed for PASS. If these can be made concurrently, the risk is reduced and the savings could be substantial. In these future aircraft, plans are to use this downlink for transference of logistics type information. PASS should become a requirement and the optimum design is to embed PASS requirements in the original requirements and design of the aircraft architecture.

AMC implementation should take advantage of the Mobility 2000 (M2K) initiative. This initiative is leveraging new technologies in communications and information systems to enhance the ability of AMC to plan, schedule, task, and execute America's mobility forces worldwide. Accurate and timely maintenance information made available via a PASS concept is vital to managing these mobility forces.

8 SUMMARY

PASS continues to be a very promising concept, with high potential for payback for flightline maintenance and as a force multiplier for operational wartime needs. All maintenance personnel we worked with saw potential capability they could capitalize upon and were excited about the possibility of the implementation for legacy aircraft. If PASS were included as part of the planned GATM avionics improvement, the cost and effort for PASS implementation would be greatly reduced. GATM requires aircraft hardware/software changes for data downlinking capability. PASS could use the same hardware/software for downlinking but would require changes to the Operational Flight Program to collect, package, route, and transmit the aircraft status information at the appropriate time intervals.

The AMC Mobility 2000 (M2K) effort will use TACC as a focal point for downlinked information and they will route information to its appropriate user. PASS information fits within this concept and can take advantage of planned M2K efforts.

ACC requires PASS ground processing stations at each recovery location. It can supplement the voice communications between the aircrew and operations and can be designed to use the same ground equipment for reception of the PASS downlinked information.